

5 We claim:

1. A method for processing a received, modulated pulse that requires predictive deconvolution to resolve a scatterer from noise and other scatterers, comprising:

a) receiving a return signal;

10 b) obtaining $L + (2M-1)(N-1)$ samples y of the return signal, where

$$y(\ell) = \tilde{\mathbf{x}}^T(\ell) \mathbf{s} + v(\ell);$$

c) applying RMMSE estimation to each successive N samples to obtain initial impulse response estimates $[\hat{x}_1\{-(M-1)(N-1)\}, \dots, \hat{x}_1\{-1\}, \hat{x}_1\{0\}, \dots, \hat{x}_1\{L-1\}, \hat{x}_1\{L\}, \dots, \hat{x}_1\{L-1+(M-1)(N-1)\}]$;

d) computing power estimates $\hat{\rho}_1(\ell) = |\hat{x}_1(\ell)|^2$ for $\ell = -(M-1)(N-1), \dots, L-1+(M-1)(N-1)$;

15 (e) computing MMSE filters according to $\mathbf{w}(\ell) = \rho(\ell) (\mathbf{C}(\ell) + \mathbf{R})^{-1} \mathbf{s}$, where

$\rho(\ell) = |x(\ell)|^2$ is the power of $x(\ell)$, and $\mathbf{R} = E[\mathbf{v}(\ell) \mathbf{v}^H(\ell)]$ is the noise covariance matrix;

(f) applying the MMSE filters to y to obtain

$[\hat{x}_2\{-(M-2)(N-1)\}, \dots, \hat{x}_2\{-1\}, \hat{x}_2\{0\}, \dots, \hat{x}_2\{L-1\}, \hat{x}_2\{L\}, \dots, \hat{x}_2\{L-1+(M-2)(N-1)\}]$; and

20 (g) repeating (d)-(f) for subsequent reiterative stages until a desired length- L range window is reached, thereby resolving the scatterer from noise and other scatterers.

2. A method as in claim 1, wherein the RMMSE estimation is performed with a plurality of parallel processors.

25 3. A method as in claim 1, further comprising setting a nominal level for which the power estimates are not allowed to fall below.

4. A method as in claim 1, wherein the y samples are obtained via A/D conversion.

30 5. A method as in claim 1, wherein the method is applied in range profiling.

6. A method as in claim 1, wherein the method is applied in a weather radar system.

35 7. A method as in claim 1, wherein the method is applied in image recognition for Synthetic Aperture Radar (SAR).

8. A method as in claim 1, wherein the method is applied in image recognition for Inverse SAR (ISAR).

40 9. A method as in claim 1, wherein the method is applied in remote sensing.

- 5 10. A method as in claim 1, wherein the method is applied in ultrasonic non-destructive evaluation for structural integrity.
11. A method as in claim 1, wherein the method is applied in seismic estimation.
- 10 12. A method as in claim 1, wherein the method is applied in biomedical imaging.
13. A method as in claim 1, wherein the method is applied in inverse filtering of optical images.
14. A radar receiver system, comprising:
- 15 a receiver;
- a processor including a Reiterative Minimum Mean-Square Error estimation (RMMSE) radar pulse compression algorithm; and
- a target detector.
- 20 15. A radar receiver system as in claim 14, wherein the RMSSE radar pulse compression algorithm comprises:
- (a) obtaining $L + (2M-1)(N-1)$ samples y of a radar return signal, where $y(\ell) = \tilde{\mathbf{x}}^T(\ell) \mathbf{s} + v(\ell)$;
- (b) applying RMMSE pulse compression to each set of N contiguous samples to obtain initial radar impulse response estimates
- 25 $[\hat{x}_1\{-(M-1)(N-1)\}, \dots, \hat{x}_1\{-1\}, \hat{x}_1\{0\}, \dots, \hat{x}_1\{L-1\}, \hat{x}_1\{L\}, \dots, \hat{x}_1\{L-1+(M-1)(N-1)\}]$;
- (c) computing power estimates $\hat{\rho}_1(\ell) = |\hat{x}_1(\ell)|^2$ for $\ell = -(M-1)(N-1), \dots, L-1+(M-1)(N-1)$;
- (d) computing range-dependent filters according to $\mathbf{w}(\ell) = \rho(\ell) (\mathbf{C}(\ell) + \mathbf{R})^{-1} \mathbf{s}$, where
- $\rho(\ell) = |x(\ell)|^2$ is the power of $x(\ell)$, and $\mathbf{R} = E[\mathbf{v}(\ell) \mathbf{v}^H(\ell)]$ is the noise covariance matrix;
- (e) applying the range-dependent filters to y to obtain
- 30 $[\hat{x}_2\{-(M-2)(N-1)\}, \dots, \hat{x}_2\{-1\}, \hat{x}_2\{0\}, \dots, \hat{x}_2\{L-1\}, \hat{x}_2\{L\}, \dots, \hat{x}_2\{L-1+(M-2)(N-1)\}]$; and
- (f) repeating (c)-(e) for subsequent reiterative stages until a desired length- L range window is reached.
16. A radar receiver system as in claim 14, further comprising a plurality of parallel processors for
- 35 performing the RMMSE pulse compression.
17. A radar receiver system as in claim 14, wherein a nominal level is set for which the power estimates are not allowed to fall below.
- 40 18. A radar receiver system as in claim 14, further comprising an analog-to-digital (A/D) converter.

5 19. A radar receiver system as in claim 15, further comprising an analog-to-digital (A/D) converter for obtaining the y samples.

20. A radar receiver system as in claim 14, wherein the system is an airport radar system.

10 21. A radar receiver system as in claim 14, wherein the system is a weather radar system.

22. A method for processing a received, modulated radar pulse to resolve a radar target from noise or other targets, comprising:

a) receiving a radar return signal;

15 b) obtaining $L + (2M-1)(N-1)$ samples y of the radar return signal, where

$$y(\ell) = \tilde{\mathbf{x}}^T(\ell) \mathbf{s} + v(\ell);$$

c) applying RMMSE pulse compression to each successive N samples to obtain initial radar impulse response estimates

$$[\hat{x}_1\{-(M-1)(N-1)\}, \dots, \hat{x}_1\{-1\}, \hat{x}_1\{0\}, \dots, \hat{x}_1\{L-1\}, \hat{x}_1\{L\}, \dots, \hat{x}_1\{L-1+(M-1)(N-1)\}];$$

20 d) computing power estimates $\hat{\rho}_1(\ell) = |\hat{x}_1(\ell)|^2$ for $\ell = -(M-1)(N-1), \dots, L-1+(M-1)(N-1)$;

(e) computing range-dependent filters according to $\mathbf{w}(\ell) = \rho(\ell) (\mathbf{C}(\ell) + \mathbf{R})^{-1} \mathbf{s}$, where

$\rho(\ell) = |x(\ell)|^2$ is the power of $x(\ell)$, and $\mathbf{R} = E[\mathbf{v}(\ell) \mathbf{v}^H(\ell)]$ is the noise covariance matrix;

(f) applying the range-dependent filters to y to obtain

$$[\hat{x}_2\{-(M-2)(N-1)\}, \dots, \hat{x}_2\{-1\}, \hat{x}_2\{0\}, \dots, \hat{x}_2\{L-1\}, \hat{x}_2\{L\}, \dots, \hat{x}_2\{L-1+(M-2)(N-1)\}];$$

25 (g) repeating (d)-(f) for subsequent reiterative stages until a desired length- L range window is reached, thereby resolving the radar target from noise or other targets.

23. A method as in claim 22, wherein the RMMSE pulse compression is performed with a plurality of parallel processors.

30 24. A method as in claim 22, wherein the y samples of the radar return signal are obtained via A/D conversion.

35 25. A method as in claim 22, further comprising setting a nominal level for which the power estimates are not allowed to fall below.

26. A method as in claim 22, wherein the method is applied in an airport radar system.

40 27. A method as in claim 22, wherein the method is applied in a weather radar system.

5 28. A method as in claim 22, wherein the y samples of the radar return signal are obtained via A/D conversion.

10 29. A method as in claim 22, wherein a plurality of radar targets are resolved and separately identified.